Computer Engineering 5610: Real-Time Digital Signal Processing
Prior Number – Computer Engineering 342

Credit and Contact Hours
2 credit hours lecture and 1 credit hour laboratory (three hour lecture/lab session per week or two 1.5 hour lecture/lab sessions are typical). The introductory concepts and mathematics are presented through a combination of in-class review lectures and a comprehensive introductory handout and presentation to accommodate differences in student backgrounds. Five laboratory exercises are included on basic DSP processing and a final semester project is aimed on problem solving skills.

Instructor
Varies – R. Zheng, Ph.D.; S. Grant, Ph.D.

Text(s)

Catalog Information
This is a 2.0 LEC and 1.0 LAB course as an introduction to the use of programmable DSP chips. It includes real-time data acquisition, signal generation, interrupt-driven programs, high-level language, and assembly level routines. Applications to real-time systems are also presented.

Prerequisites
Electrical Engineering 3410 (215) and Computer Engineering 3150 (213). Linear systems theory and Fourier transforms, Digital System Design, basic skills of Matlab or C programming

Required or Elective
Elective course

Course Goals
General Outcomes
1. Learn to represent real world signals in digital format and understand transform-domain (Fourier and z-transforms) representation of the signals;
2. Learn to apply the linear systems approach to signal processing problems using high-level programming language;
3. Learn the basic architecture of microprocessors and digital signal processors;
4. Learn to implement linear filters in real-time DSP chips;
5. Introduce applications of linear filters and their real-time implementation challenges.
Relationship of Course to Program Outcomes

<table>
<thead>
<tr>
<th>CpE Objective</th>
<th>Course Objective</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>S S M M S</td>
<td>The linear systems theory is applied to DSP implementations.</td>
</tr>
<tr>
<td>b</td>
<td>S M S S S</td>
<td>Five labs and a final semester project train hands-on skills</td>
</tr>
<tr>
<td>c</td>
<td>S M M S S</td>
<td>Applications are linked to fundamental knowledge</td>
</tr>
<tr>
<td>d</td>
<td>M M M S S</td>
<td>Labs are conducted in teams</td>
</tr>
<tr>
<td>g</td>
<td>M M S S S</td>
<td>Lab reports gives training on written communication skills</td>
</tr>
</tbody>
</table>

S – strong connection; M – medium connection; W – weak connection

Topics Covered

1. Introduction to Digital Signal Processing (Week 1)
   - Analog vs. Digital Systems
   - Nyquist Sampling Theorem
   - ADC and DAC
   - Signal Source Generation
2. Fundamentals of Digital Signals and Systems (Week 2)
   - Discrete Time Linear Systems
   - Impulse Responses
   - z-Transforms
   - Discrete Fourier Transforms (DFT)
3. Digital Filter Design (Week 3)
   - Filter Basics
   - FIR Filter
   - IIR Filters
4. Review of microprocessor/microcomputer architecture (Week 5)
   - Von Neumann and Harvard Architectures
   - Central Processing Unit (CPU)
   - Data and Address Bus Structure
   - I/O and Interrupts
5. Architecture of DSP chip used in class (Week 7)
   - CPU and Bus Structure
   - Timing and Control
   - Addressing Formats
   - Configuration of Evaluation Board
6. Programming of DSP Chip (Week 9/10)
   - Interrupt Driven Programs
   - Circular Buffer
   - Frame Processing
   - Real-Time Scheduling
7. DSP Applications (Week 12/13)
   - Audio Signal Processing
   - Image Processing
   - Data Compression/Transmission
   - Wireless Communications